5 /PRTS

10/535626

JC14 Rec'd PCT/PTO 20 MAY 2005

TITLE OF THE INVENTION

Light Source Device for Three-Dimensional Display

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a light source device for three-dimensional display which rapidly turns on a small number of LEDs to present a stereoscopic image to an observer in a wide range of viewing angle even if the observer moves sideways or the image is viewed by two or more observers from multiple visual points. More particularly, the invention relates to a light source device for three-dimensional display that has an image display means for creating an image using transmitted light.

DESCRIPTION OF THE PRIOR ART

A technology for visualizing an object in three dimensions has been under development and studies on a method of displaying a three-dimensional image has been conducted in many fields, with a variety of techniques already put to practical use. There are two types of three-dimensional visualization system. One type requires an observer to wear a device such as special eyeglasses or goggles and the other uses no special device on the observer.

The first system (eyeglass type) includes a so-called anaglyph system, in which a viewer wears a pair of eyeglasses, one attached with a red filter and the other with a blue filter; and a polarized eyeglass system, which uses a pair of eyeglasses attached with polarizing filters that transmit linearly polarized light and whose transmission axes are set perpendicular to each other. In these systems a viewer sees with his two eyes disparate images of an object that produce the binocular parallax so that the viewer can see a generally stereoscopic view. However, with these systems the viewer needs to wear cumbersome special eyeglasses.

Among proposed stereoscopic display systems that do not use the special eyeglasses are a parallax barrier system and a lenticular system.

Japanese Patent Disclosure No. 10-63199 discloses a stereoscopic imaging system in which, as shown in Fig. 5, a right-eye polarizing filter portion 66a and a left-eye polarizing filter portion 66b with their polarizing axes set perpendicular to each other are arranged on the left- and right-side areas of a light emitting surface of a two-dimensional or planar light source 65; in which rays of light that have passed through the filter portions 66a, 66b are collimated by a Fresnel lens 63 into parallel rays that are then projected onto a liquid crystal device 62; and in which the liquid crystal device 62 has on both surfaces thereof linear polarizing filters 621, 622 each comprising horizontal lines of filters La, Lb having their polarizing axes set perpendicular to each other, with the horizontal filter lines La, Lb alternated in the vertical direction. In this example, the opposing linear polarizing filter lines, one on the light source 65 side and the other on the viewer side, are set such that their polarizing axes are perpendicular to each other. A liquid crystal panel 620 of the liquid crystal device 62 has an image formed thereon so that image information for the right eye and image information for the left eye are arranged along the horizontal filter lines of the two opposite polarizing filters and alternated in the vertical direction, permitting either of the image information to appear every other horizontal line.

In any of the systems described above -- the binocular parallax barrier system, the lenticular system and the system disclosed in Japanese Patent Disclosure No. 10-63199 -- since the stereoscopic viewing range is limited, if the observer's position is shifted left or right even slightly, the stereoscopic image is inverted left or right or only a planar image is displayed. Another problem with these systems is that an image can only be presented to a single observer. To deal with these problems, a method has

been proposed which involves measuring the position of an observer and mechanically moving the light source (as indicated by an arrow A in Fig. 5) according to the observer's movement. This method, however, is not practical because of its slow response speed and because a mechanically driving device easily wears out and lacks a sufficient durability. Further, when an observer shifts sideways, he or she cannot see the intended stereoscopic image.

Further, in a case where a stereoscopic image source is received, even if the same planar images for the left and right eyes are displayed at the same time, the two planar images reaching the left and right eyes have half an original resolution of the liquid crystal device because the left and right eyes receive the left- and right-eye planar images separately.

The present invention has been accomplished to overcome these problems. A first object of the present invention is to provide a highly precise and durable light source device for three-dimensional display which does not use a mechanical construction and thus can rapidly move an illuminating point on a light source to a position that best matches the positional movement of an observer. In this invention, a control to move the position of an illuminating point on a light source is referred to as a turn-on control.

A second object of this invention is to provide a light source device for three-dimensional display which can turn a light source on and off at a speed high enough to allow the light source to be turned off during synchronization signal and blanking periods to eliminate unwanted afterimages and interferences and reduce power consumptions significantly. In this invention, a control for turning off the light source during the synchronization signal and blanking periods is referred to as a turn-off control.

A third object of this invention is to provide a light source device for three-dimensional display which, when used on a time-division type three-dimensional display, can obviate the use of a shutter device in a light source thus simplifying the construction and eliminating a light transmission loss.

A fourth object of this invention is to provide a light source device for three-dimensional display which, with a limited number of LEDs as a light source, can form a wide viewing angle image on a two- or three-dimensional display. In this case, by using a known eye position tracking device, such as an ultrasonic tracking device, infrared tracking device or image tracking device, it is possible to present a stereoscopic image to an observer even if eyes of the observer move or the display is viewed by two or more observers.

A fifth object of this invention is to provide a light source device for three-dimensional display which can easily display a stereoscopic image source as a planar or two-dimensional image. That is, even if the same planar images for the left and right eyes (planar image source) are presented to both eyes, the image cannot be seen at an increased resolution because the left and right eyes receive the left- and right-eye images separately. It is therefore desired that the three-dimensional display can also display a planar image.

SUMMARY OF THE INVENTION

The present invention solves the above-mentioned problems with the following means.

A first aspect of the present invention provides a light source device for three-dimensional display having an image display means, wherein the image display means forms an image using transmitted light, the light source device comprising: an LED array having white LEDs or RGB LEDs arranged in two horizontal rows one above the

other; and an LED control means for performing an on-off control on the horizontal rows of the white LEDs or RGB LEDs in the LED array.

With this invention, since the light source uses white LEDs or RGB LEDs that have a small power consumption and a fast on-off switching speed, the control of the LED control means makes it possible to turn on or off any of the LEDs of the light source and reduce the power consumption.

A second aspect of the present invention provides a light source device for three-dimensional display according to the first aspect, wherein the display is a three-dimensional display to present different images to right and left eyes of an observer and the upper and lower LED arrays constitute a light source portion for presenting an image for the right eye and a light source portion for presenting an image for the left eye, respectively.

With this invention, a stereoscopic image visualization control with a high degree of freedom can be realized by controlling the turn-on of the right- and left-eye image light source portions in the LED array by the LED control means.

A third aspect of the present invention provides a light source device for three-dimensional display according to the second aspect, wherein the display has a position identifying means which measures a position of an observer relative to the display and outputs a corresponding position signal, and the LED control means performs a turn-on control on the white LEDs or RGB LEDs based on the position information so as to keep an image viewable by the observer.

With this invention, illuminating points in the right- and left-eye image light source portions can be moved, according to the observer position information, at high speed to positions that match the position of an observer. During this process no mechanical actions are performed, assuring high precision and high durability.

A fourth aspect of the present invention provides a light source device for three-dimensional display according to the second aspect, wherein the display has a controller operated by the observer, and the LED control means performs a turn-on control on the white LEDs or RGB LEDs based on operation information from the controller so as to change an image viewed by the observer.

With this invention, illuminating points in the right- and left-eye image light source portions can be moved at high speed to any desired positions by the observer operating the controller. During this process no mechanical actions are performed, assuring high precision and high durability.

A fifth aspect of the present invention provides a light source device for three-dimensional display according to the second aspect, wherein the display has a position identifying means which counts the number of observers, measures positions of the observers relative to the display and outputs corresponding position signals, and the LED control means performs a turn-on control on the white LEDs or RGB LEDs based on the position information so as to keep images viewable by the observers.

With this invention, appropriate stereoscopic images can be presented to a plurality of viewers located at different positions.

A sixth aspect of the present invention provides a light source device for three-dimensional display according to the second aspect, wherein the right-eye image light source portion and the left-eye image light source portion of the LED array are on-off controlled.

In a three-dimensional display that displays right- and left-eye images in a time-division manner, this invention can obviate the use of a shutter device in a light source thus simplifying the construction and eliminating a light transmission loss.

A seventh aspect of the present invention provides a light source device for

three-dimensional display according to the second aspect, wherein the LED control means changes an interval between lighted parts of the right-eye image light source portion and the left-eye image light source portion of the LED array according to a distance of an observer from the display.

With this invention, an appropriate stereoscopic image can be presented to an observer wherever the observer is located by changing the interval between the lighted parts of the right- and left-eye image light source portions according to the position of the observer.

An eighth aspect of the present invention provides a light source device for three-dimensional display according to the first aspect, wherein the two horizontal rows, one above the other, of the white LEDs or RGB LEDs in the LED array are arranged such that the LEDs in one of the rows are placed side by side with or staggered from those in the other row, and the LED control means performs the on-off control on the LED horizontal rows in the LED array.

With this invention, the right- and left-eye LEDs at the central portion of the LED array can easily be separated from each other, reducing interferences and crosstalks between the right-eye image and the left-eye image which adversely affect a stereoscopic image formed. The crosstalk reduction is realized because light interferences between the right- and left-eye illuminating LEDs are prevented by their vertical separation, i.e., the right- and left-eye illuminating LEDs are arranged in the upper and lower rows in the LED array, respectively. In this case, if a partition wall or the like is arranged between the upper and lower rows of LEDs, the crosstalks can better be prevented. When the two rows of LEDs are turned on simultaneously, the light quantity doubles, forming a brighter image. Further, the simultaneous lighting of the two LED rows can display a planar image from a stereoscopic image signal.

That is, when a planar image signal is received, it is transferred in the same signal transmission mode as used in transferring a stereoscopic image signal. This enables a high resolution planar image to be displayed by only performing simple turn-on processing on the LED array on the receiving side.

According to a ninth aspect of the present invention, the LED control means turns on and off appropriate white LEDs in the LED array and scans the illuminating LEDs across the LED array at high speed in a horizontal direction. When applied to a two-dimensional display, this invention can form a wide viewing angle image with a limited number of LEDs as a light source.

According to a tenth aspect of the present invention, the light source device for three-dimensional display can be used on three- or two-dimensional displays of television sets, game machines, personal computers, cell phones or mobile terminals.

This invention enables a stereoscopic image to be formed not only on large screens of television sets, game machines and personal computers but also on small screens of cell phones and mobile terminals which can easily move relative to sight lines of observers. This invention also allows these screens to be used as two-dimensional displays that require a wide viewing angle.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a display that uses a light source device for three-dimensional display according to a first embodiment of the invention.

Fig. 2 illustrates a display that uses a light source device for three-dimensional display according to a first embodiment of the invention.

Fig. 3 illustrates a display that uses a light source device for three-dimensional display according to a first embodiment of the invention.

Fig. 4 illustrates a display that uses a light source device for three-dimensional

display according to a second embodiment of the invention.

Fig. 5 illustrates an example of a conventional three-dimensional display.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now, embodiments of the present invention will be described by referring to the accompanying drawings.

Fig. 1 to Fig. 4 show embodiments of this invention, Fig. 1 to Fig. 3 representing a first embodiment of the invention and Fig. 4 a second embodiment.

In the following description it is assumed that a display used is a three-dimensional display. In the embodiments that follow, an image display means may use basically the same construction as the display disclosed in Japanese Patent Disclosure No. 10-63199. In that case, as shown in Fig. 5, the image display means has a right-eye polarizing filter portion 66a and a left-eye polarizing filter portion 66b. Rays of light that have passed through the filter portions 66a, 66b are collimated by the Fresnel lens 63 into parallel rays that are then projected onto the liquid crystal device 62.

(First Embodiment)

In this embodiment, as shown in Fig. 1 and Fig. 2, a light source device 50 for three-dimensional display has an LED array 51 constructed of two tiers, an upper tier 51U and a lower tier 51D. Disposed in front of white LEDs 1 of the LED array 51 is a polarizing filter 54 which has right- and left-eye polarizing filters 54U, 54D corresponding to the upper tier 51U and lower tier 51D of the LED array 51. The polarizing filters 54U, 54D transmit light from the upper tier 51U and the lower tier 51D of the LED array 51, respectively, and have their polarization axes set perpendicular to each other.

An LED control means 53 performs an on-off control on each LED array 51U, 51D.

First, let us explain about a case where there is only one observer 70.

A position of the observer 70 is checked by a position identifying means, and an illuminating region 73 of the upper and lower LED arrays 51U, 51D is turned on to present a stereoscopic image to the observer 70. At this time, the illuminating region is moved according to the position of the observer 70 detected by the position identifying means 55 to present a stereoscopic image to the observer. When the observer is located at the center of the LED array 51, it is of course not necessary to provide the position identifying means 55.

Next, a case of two observers 70, 71 will be explained. In this case, as shown in Fig. 1 and Fig. 2, the LED control means 53 receives signals from the position identifying means 55, sets two illuminating regions 73, 74 on the two LED arrays 51U, 51D, and performs a turn-on control on these illuminating regions alternately at high speed. During this process, other LEDs 1 than those of the illuminating regions 73, 74 are not lighted and, at any given instant, only one of the illuminating regions 73, 74 illuminates. As shown in Fig. 1, the light source device 50 includes an LED array 51 having a plurality of white LEDs 1 arranged in a plurality of horizontal, parallel rows, an image display means 52 and a Fresnel lens acting as a convex lens. The image display means 52 may use a transmission type liquid crystal panel.

The LED array 51 is turned on and off by the LED control means 53. In Fig. 1 reference number 55 represents a position identifying means that measures the positions of the observers 70, 71. The position identifying means 55 uses a known position detection means of infrared or ultrasonic type to locate the positions of the observers 70, 71 and sends information on the observers' position to the LED control means 53.

In this embodiment, the LED control means 53 quickly turns on and scans

illuminating regions of the white LEDs 1 in the LED array 51 to the left and right. In Fig. 1, lit LEDs are represented by black dots "•" and unlit LEDs by blank dots "o" (this representation also applies in the following description).

By performing the turn-off control that turns off the white LEDs 1 during the synchronization signal and blanking periods of the image display means 52, not only can unwanted afterimages and interferences be eliminated but the power consumption can also be reduced. Further, in a three-dimensional display the light source device using a small number of LEDs as a light source in combination with the Fresnel lens can produce an image with a wide viewing angle.

In this embodiment, since the right-eye LED array and the left-eye LED array are separated vertically, the distance between the illuminated regions for the right and left eyes increases, reducing interferences between rays of light from these illuminated regions, which in turn reduces crosstalks between right- and left-eye images that have adverse effects on a stereoscopic image produced.

Further, as shown in Fig. 2, if in addition to regions 62, 63 in the two LED arrays 51U, 51D for the right and left eyes, LEDs in regions 64, 65 located above and below the regions 62, 63 are also illuminated at the same time, images supplied as a three-dimensional image to the image display means are both displayed as two-dimensional or planar images to the observer 70. In this case, since a light quantity doubles, a brighter image can be displayed. A switchover between a stereoscopic image and a planar image can easily be done by an electric control and requires no mechanical control. This means no mechanical wear occurs.

(Second Embodiment)

In this embodiment, as shown in Fig. 4, a light source device 50 for three-dimensional display has an LED array 51 constructed of two tiers, an upper tier 51U

and a lower tier 51D, with white LEDs 1 of these tiers staggered in a horizontal position.

In this embodiment, the right- and left-eye LEDs at the central portion of the LED array can easily be separated from each other, reducing interferences. That is, this embodiment can reduce crosstalks between the left- and right-eye images and therefore adverse effects on a stereoscopic image formed.

The use of the three-dimensional display of this invention may for example include, but is not limited to, display portions of television sets, game machines, personal computers, cell phones and mobile terminals.

Although the LED array 51 in this embodiment is made up of white LEDs, each of the LEDs in the LED array may be formed by combining three primary color LEDs, or RGB LEDs, so that the RGB LEDs as a whole produce white light.

Further, it should be noted that the light source device for three-dimensional display according to this invention is not limited in construction to the embodiments described above and that a variety of modifications may be made without departing from the spirit of the invention.

INDUSTRIAL APPLICABILITY

As described above, the light source device for three-dimensional display according to the present invention offers the following advantages.

According to a first aspect of this invention, since two horizontal rows of LEDs, upper and lower LED arrays, with a small power consumption and a fast on-off switching speed are used as a light source to display a right-eye image and a left-eye image, respectively, any desired point on the light source can be turned on or off by controlling the LED control means and the power consumption of the light source device reduced.

According to a second aspect of this invention, a stereoscopic image

visualization control with a high degree of freedom can be realized by controlling the turn-on of the right- and left-eye image light source portions in the LED array by the LED control means.

According to a third aspect of this invention, illuminating points in the right- and left-eye image light source portions can be moved, according to observer position information, at high speed to positions that match the position of an observer. Since during this process no mechanical actions are performed, the control can be made with high accuracy and high durability.

According to a fourth aspect of this invention, illuminating points in the right- and left-eye image light source portions can be moved at high speed to any desired positions by the observer operating the controller. Since during this process no mechanical actions are performed, the control can be made with high accuracy and high durability. Even if an observer position shifts sideways, he or she can reliably see a stereoscopic image.

According to a fifth aspect of this invention, since the display has a position identifying means which counts the number of observers, measures positions of the observers relative to the display and outputs corresponding position signals and since the LED control means performs an on-off control on the white LEDs based on the position information so as to keep images viewable by the observers, appropriate stereoscopic images can be presented to a plurality of viewers located at different positions.

According to a sixth aspect of this invention, since the right- and left-eye image light source portions of the LED array are on-off controlled , a shutter device in a light source can be obviated in a three-dimensional display that displays right- and left-eye images in a time-division manner. This in turn simplifies the construction

and eliminates a light transmission loss.

According to a seventh aspect of this invention, since the LED control means changes an interval between lighted parts of the right- and left-eye image light source portions of the LED array according to a distance of an observer from the display, an appropriate stereoscopic image can be presented to the observer wherever the observer is located by changing the interval between the lighted parts of the right- and left-eye image light source portions according to the position of the observer.

According to an eighth aspect of this invention, since the two horizontal rows, one above the other, of the white LEDs or RGB LEDs in the LED array are arranged such that the LEDs in one of the rows are staggered from or placed side by side with those in the other row, and the LED control means performs the on-off control on the LED horizontal rows in the LED array, the right- and left-eye LEDs at the central portion of the LED array can easily be separated from each other, reducing interferences and crosstalks between the right-eye image and the left-eye image which adversely affect a stereoscopic image formed. The crosstalk reduction is realized because light interferences between the right- and left-eye illuminating LEDs are prevented by their vertical separation, i.e., the right- and left-eye illuminating LEDs are arranged in the upper and lower rows in the LED array, respectively. In this case, if a partition wall or the like is arranged between the upper and lower rows of LEDs, the crosstalks can better be prevented. When the two rows of LEDs are turned on simultaneously, the light quantity doubles, forming a brighter image. Further, the simultaneous lighting of the two LED rows can display a planar image from a stereoscopic image signal.

According to a ninth aspect of this invention, since the LED control means turns on and off appropriate white LEDs in the LED array and scans the illuminating

LEDs across the LED array at high speed in a horizontal direction, a wide viewing angle image can be created with a limited number of LEDs as a light source in a two-dimensional display.

According to a tenth aspect of this invention, a stereoscopic image can be formed not only on large screens of television sets, game machines and personal computers but also on small screens of cell phones and mobile terminals which can easily move relative to sight lines of observers. These screens can also display two-dimensional images that require a wide viewing angle.